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National Petroleum Reserve-Alaska Landcover Inventory: Phase 1 Western NPR-A

FINAL REPORT

Submitted to:

U.S. Department of the Interior
Bureau of Land Management
Alaska State Office
222 West 7th Avenue, #13
Anchorage, Alaska
USA 99513-7599

May 1995

Pacific Meridian Resources
9823 Old Winery Place, #16
Sacramento, California
USA 95827-1720

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1995
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Ducks Unlimited, Inc., Contract No. AK-0012-001
BLM Agreement No. L953-A1-0017 T4 MOD.Z
Pacific Meridian Resources Job No. 332

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Table of Contents

Abstract 1
Introduction 1
Project Objective 4
Project Area 4
Data Acquisition 6
Methods 6
  Image preprocessing 6
  Field verification 8
  Classification Scheme 10
  Classification 12
  Stitching the classifications 14
  Accuracy assessment 14
  Eider habitat 15
Results 15
  Classification 15
  Eider Analysis 16
  Accuracy Assessment 17
  Project Cost 19
Conclusions 20
Acknowledgments 20
Literature Cited 21
APPENDIX A 23
APPENDIX B 26

List of Tables

TABLE 1. THE CLASSIFICATION SCHEME FOR THE NPR-A.....8
TABLE 2. THE NUMBER OF FIELD SAMPLES PER CLASS AND NUMBER WITHHELD FOR ACCURACY ASSESSMENT. 10
TABLE 3. COMPARISON BETWEEN THE INITIAL AND LANDSAT TM CLASSIFICATION SCHEMES....11
TABLE 4. THE AREA AND PERCENTAGE OF THE SEVEN MAJOR CLASSES. 15
TABLE 5. THE AREA AND PERCENTAGE OF THE SIXTEEN MINOR CLASSES. 17
TABLE 6. THE ACCURACY ASSESSMENT OF THE PHASE A CLASSIFICATION.....19
TABLE 8. THE COST OF IDENTIFYING THE LAND COVER IN THE WESTERN NPR-A WITH LANDSAT TM DATA. 19

List of Figures

FIGURE 1. THE MORPHOLOGY OF THE ORIENTED -THAW-LAKES OF THE NPR-A.....2
FIGURE 2. AN EXAMPLE OF ANCIENT AND PRESENT ORIENTED-THAW-LAKES.....3
FIGURE 3. THE PROJECT AREA FOR PHASE A OF THE NPR-A PROJECT. 5
FIGURE 4. THE TWO TERRAIN CORRECTED LANDSAT THEMATIC MAPPER IMAGES. 7
FIGURE 5. FIELD DATA COLLECTION CARD FOR THE NPR-A.....9
FIGURE 6. THE CLASSIFICATION PROCESS OF THE NPR-A. 13
FIGURE 7. RESULTS OF THE LANDSAT TM CLASSIFICATION.....16
FIGURE 8. THE FINAL CLASSIFICATION OF THE NPR-A PHASE A. 18

Abstract

The National Petroleum Reserve in Alaska (NPR-A) includes over 9.4 million hectares (23.4 million acres) and is located on the North Slope of Alaska, much of which falls within the Arctic Coastal Plain physiographic province. The Arctic Coastal Plain contains one of the largest and most stable collections of wetlands in North America. The objective of this project is to create an updated and detailed land cover inventory in computer database format for the entire NPR-A. In addition, an attempt will be made to relate information on observed spectacled eider locations to land cover types. The NPR-A project has been split into three phases because of the immense size of the project area and limited field access due to climate and lack of aircraft support infrastructure. These phases are planned to be completed in 1995, 1996, and 1997, respectively. This report will focus on the first phase, the inventory of the western portion of NPR-A. The cooperators in this project include BLM-Alaska, Ducks Unlimited, U.S. Fish and Wildlife Service, North Slope Borough and Pacific Meridian Resources.

Two near date Landsat Thematic Mapper (TM) satellite scenes, specifically, path 79/row 10 collected 8 July 1992 (shifted 21% south) and path 81/row 10 collected 6 July 1992 (shifted 42% south), were used to classify the project area into land cover categories. An unsupervised clustering or seeding technique was used to determine the location of field sites. A custom field data collection card was used to record field information. After initial on-the-ground sampling, two helicopters were utilized to gain access to field sites throughout the project area. Global positioning system (GPS) technology was used both to navigate to preselected sites and record locations of new sites selected in the field. Data were collected on over 600 field sites during a 9-day span using the two helicopters and field crews. A portion (45%) of these field sites were set aside for accuracy assessment.

The results of this classification suggest dominant land cover at 39% moist tundra, 21% open water, 15% flooded tundra, 11% shrub, 8% wet tundra, 4% aquatic, and 2% barren ground. The overall accuracy of the major categories was 91%, with an 82% overall accuracy for the minor categories. Analysis of known spectacled eider locations resulted in categorizing the land cover types where spectacled eiders were sighted in the field. The land cover mix related to spectacled eider locations is as follows: 73% water, 12% Carex aquatilis, 5% Arctophylla fulva, 3% wet tundra, 2% low centered polygons, and 2% non-pattern.

Introduction

Presidential declaration established the 9,470,000 hectare (23.4 million acre) Naval Petroleum Reserve No. 4 in 1923. In 1976, management responsibility of the Reserve was transferred to the Department of the Interior and the area was renamed the National Petroleum Reserve in Alaska (NPR-A). NPR-A is located on the North Slope of Alaska, much of which falls within the Arctic Coastal Plain physiographic province. The Arctic Coastal Plain contains one of the largest and most stable collections of wetlands in North America (Wellein and Lumsden 1964). Lake and

emergent marsh coverage has been estimated at 50 % of the total area (Hussey and Michelson 1966). These wetlands support large numbers of breeding and postbreeding waterfowl, loons, terns, gulls, and shorebirds, including the federally listed spectacled and Steller's eider (listed under the authority of the Endangered Species Act of 1973, as amended). The king eider migration alone has been estimated at one million birds passing Point Barrow (King and Lensink 1971). The interspersed tundra habitats are used by caribou, brown bear, polar bear, foxes, lemmings, ptarmigan, passerines, and raptors. There are millions of thermokarst pits among the shallow soils overlaying continuous permafrost. This region has little or no relief and mimics desert precipation levels with less than 10.9 cm (4.3 inches) in the average year. The cool summer growing season is approximately 6 weeks in length with continuous 24 hour daylight.

The most prominent features of the arctic coastal plain are the large oriented-thaw-lakes and second or later generation wetland landscape (Black and Barksdale 1949, Walker and Acevedo 1987, Markon and Derksen 1994). Morphology of the oriented-thaw-lakes changes with stages of development (Fig. 1). At the early stages, a lake basin is filled with water and will eventually be drained and filled with vegetation. A portion of a Landsat TM image displays some examples of the different stages of oriented-thaw-lake basin development (Fig. 2).

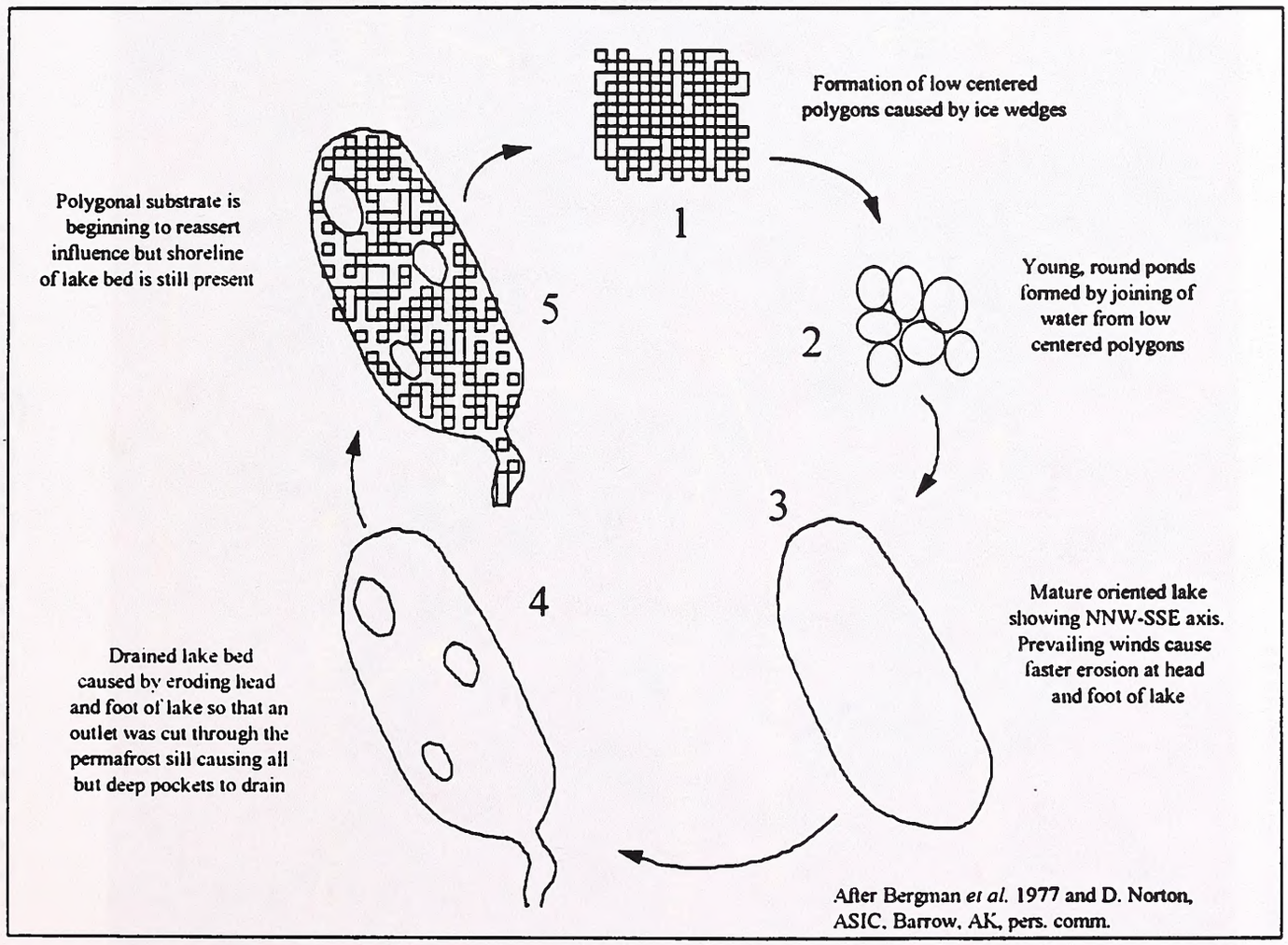
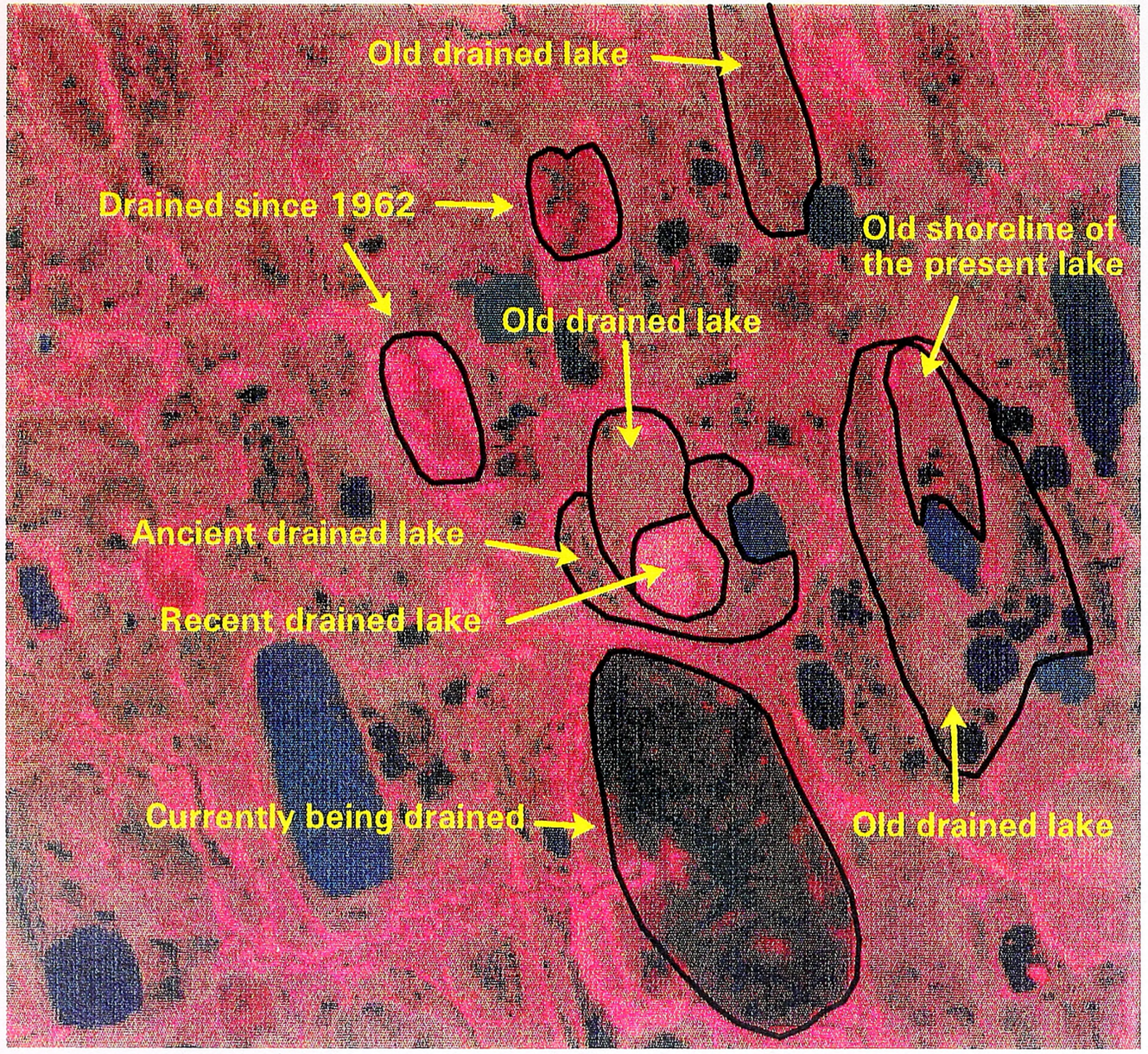

Formation of low centered polygons caused by ice wedges
1
Young, round ponds formed by joining of water from low centered polygons
2
3
Mature oriented lake showing NNW-SSE axis. Prevailing winds cause faster erosion at head and foot of lake
4
Drained lake bed caused by eroding head and foot of lake so that an outlet was cut through the permafrost sill causing all but deep pockets to drain
5
Polygonal substrate is beginning to reassert influence but shoreline of lake bed is still present
After Bergman et al. 1977 and D. Norton, ASIC, Barrow, AK, pers. comm.

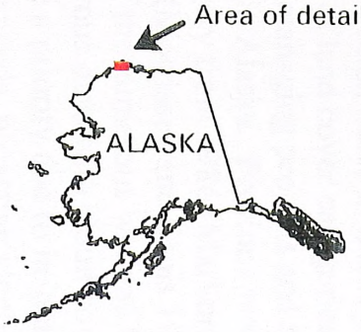
Figure 1. The morphology of the oriented -thaw-lakes of the NPR-A.

Different Stages of Lake Development



Landsat Thematic Mapper Scene
Path 79/Row 10 Shifted 21% South
July 8, 1992

Band Combination : 4,3,2



Source : Carson and Hussey 1962

Figure 2. An example of ancient and present oriented-thaw -lakes.

Land management decisions are often made in this region with little or no information regarding the size, distribution, and type of land cover categories present. Federal and state agency resources staff responsible for managing projects and addressing public issues is relatively small in relation to the huge land mass in Alaska. Previous work has concentrated on the Teshekpuk Lake area using SPOT satellite imagery from 1986 (Markon and Derksen 1994) and the NPR-A using Landsat MSS data from 1977 (Morrissey and Ennis 1981). The arctic coastal plain is very difficult to evaluate because of the numerous wetland basins, lack of roads, rapidly changing weather conditions, and numerous days with cloud cover. The need for natural resources data in this area of Alaska has become a priority due to heightened interest in onshore oil development. As development in the arctic expands, proactive identification of critical wildlife habitats is essential to make viable land use decisions.

The NPR-A project has been split into three phases due to the immense size of the project area, limited field access caused by harsh climate regime, and lack of aircraft support infrastructure. These phases are planned for completion in 1995, 1996, and 1997 (Fig. 3). This report will focus on the first phase to complete inventory of the western portion of NPR-A. The cooperators in this project include BLM-Alaska, Ducks Unlimited, U.S. Fish and Wildlife Service, North Slope Borough and Pacific Meridian Resources.

Project Objective

The objective of this project is to develop a baseline land cover inventory using Landsat TM satellite imagery in geographic information system (GIS) form for the National Petroleum Reserve in Alaska. In addition, an attempt will be made to relate information on known spectacled and Steller's eider locations to land cover types. The result of this project will be a GIS database that can be used for improved natural resources planning, such as monitoring the condition of various wetland communities. In addition, it will assist in determining impacts for oil/gas pipeline corridors should development of this region occur. These data will also be valuable in modeling the type of habitat that is being used by various wildlife species, such as the threatened spectacled and Steller's eiders.

Project Area

The project area (Fig. 3), the western portion of the NPR-A, is located on the arctic coastal plain, which is an emergent portion of the coastal shelf that has characteristically long cold winters and short cool summers (Carson and Hussey 1962). In areas near the coast, snow remains on the ground until late June and ice is on the deeper lakes until the latter part of July. Shallow soils remain frozen from mid-September to mid-May and are underlain by continuous permafrost, which contains marine silts, sands, and gravels of the Pleistocene Gubik Formation (Felix and Binney 1989, Carson and Hussey 1962).

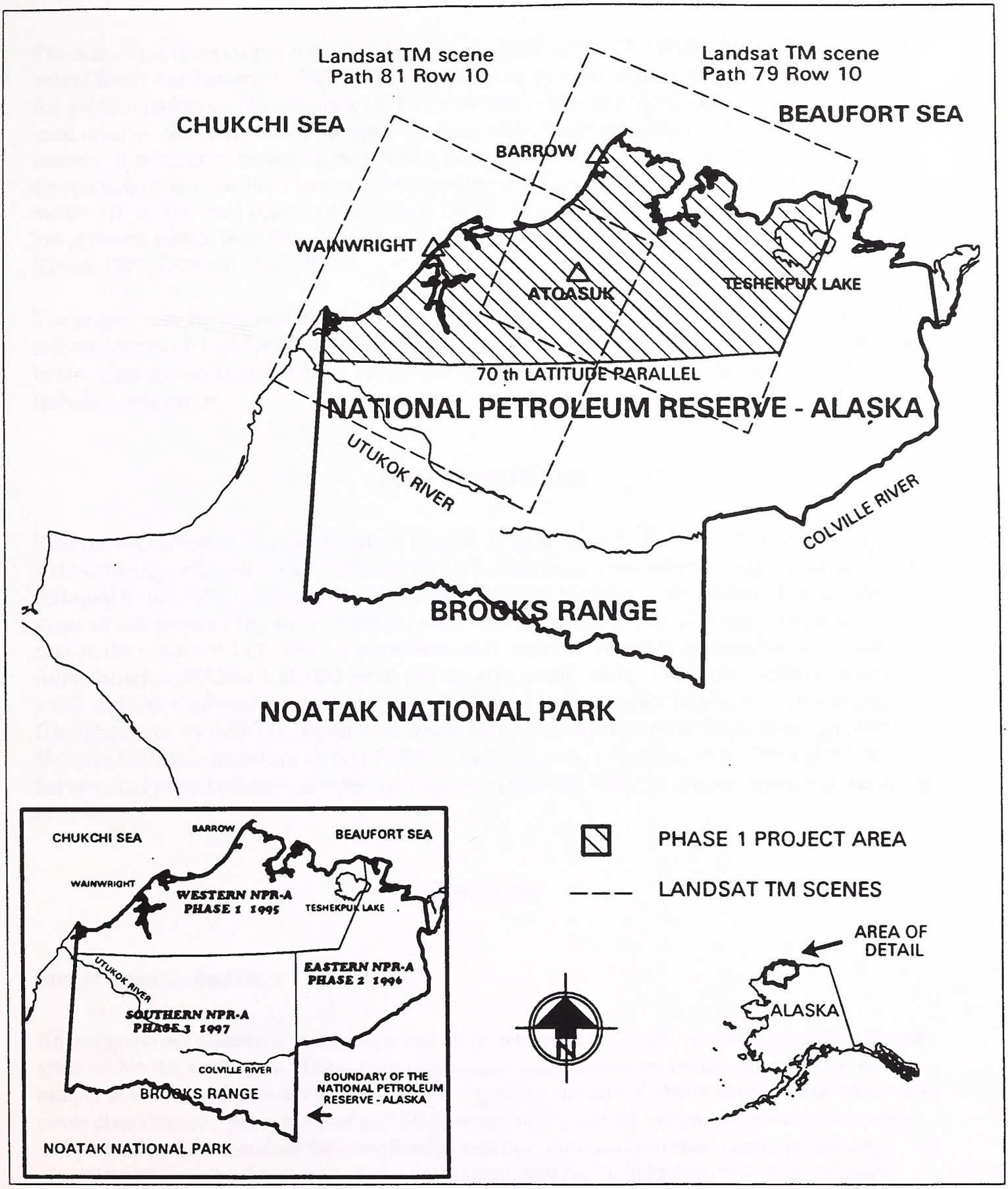


Figure 3. The project area for phase 1 of the NPR-A project.

The size of the lakes ranges from a few meters to approximately 7 km by 2 km (4.3 miles by 1.2 miles)(Black and Barksdale 1949). The only major relief in the arctic coastal plain is caused by the gentle undulations characteristic of most continental shelves (Carson and Hussey 1962). The local relief is consistent with most tundra regions where there is permafrost below 24-48 cm (9-19 inches). It consists of polygonal patterned ground caused by the accumulation of ice in large contraction cracks and thaw basins. The diameter of the polygonal areas range from 3 to 30 meters (10 to 100 feet) (Carson and Hussey 1962). The vegetation is composed of tundra with low growing plants, including dwarf shrubs, sedges, grasses, forbs, mosses, and lichens (Felix and Binney 1989, Derksen *et al.* 1981).

The project area for the first phase (Fig. 3) is composed of approximately 2.9 million of the 9.4 million hectare (7.1 million of the 23.4 million acre) NPR-A. It is bordered on the north and west by the Chukchi and Beaufort Seas, on the east by Teshekpuk lake and on the south by the 70° latitude demarcation.

Data Acquisition

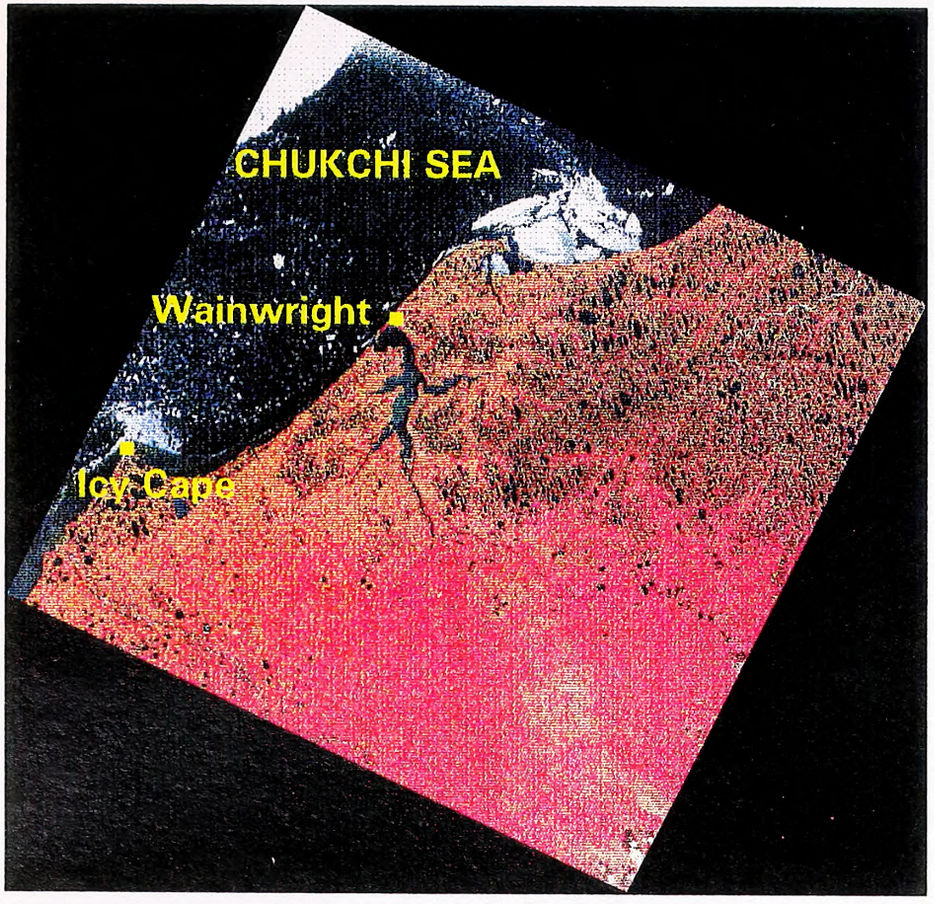
Two terrain corrected Landsat Thematic Mapper images, specifically, path 79/row 10 (ID # 94124018-01) collected 8 July 1992 (shifted 21% south) and path 81/row 10 (ID # 94124017-01) collected 6 July 1992 (shifted 42% south), were used for the land cover classification for the first phase of this project (Fig. 4). In addition, data were collected at over 600 field sites over a 9 day span in the middle of July 1994. The ancillary data includes: National Aeronautics and Space Administration (NASA) 1:60,000 aerial photographs (color prints, 1977; color infrared prints 1985; and color infrared transparencies, 1979); Digital hydrographic data from United States Geological Survey (USGS) Digital Line Graph data edited by the North Slope Borough (1993); National Wetlands Inventory (NWI) 1:63,360 hard copy maps from the U.S. Fish and Wildlife Service; and point locations of eider sightings from Fish and Wildlife Service surveys in the Spring of 1994.

Methods

Image preprocessing

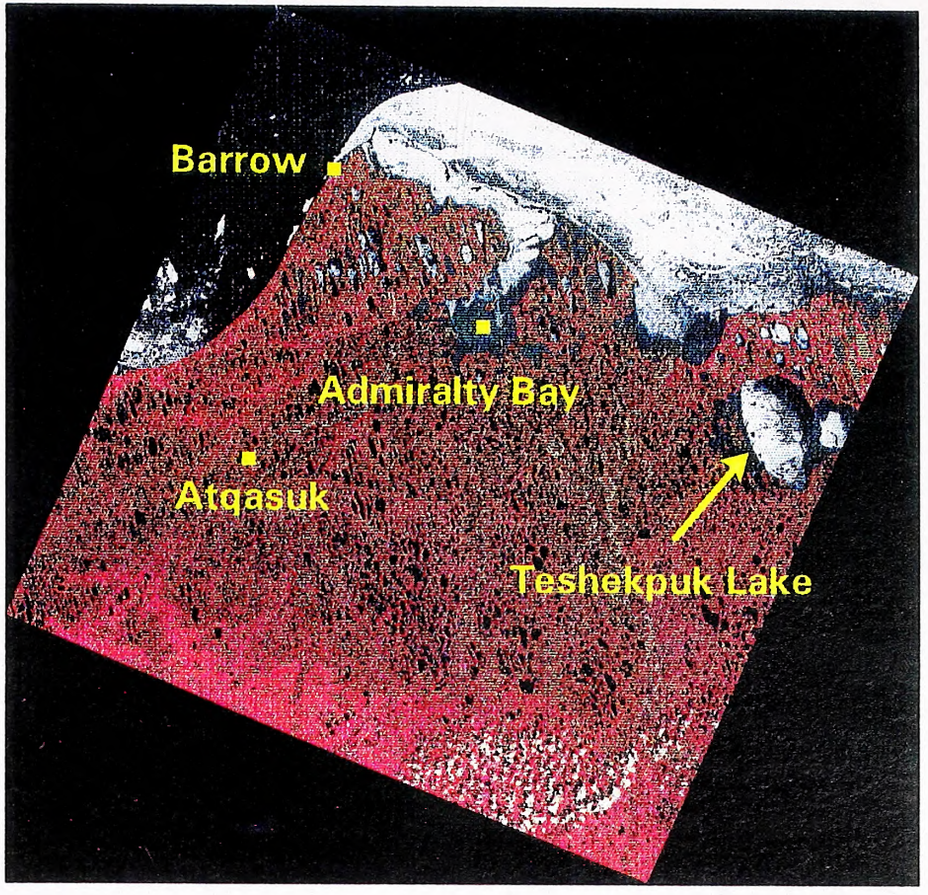
An unsupervised clustering and seeding technique was used to initially generate spectrally unique areas within the study area. These spectrally unique areas were then refined and selected as sample sites for the field work using aerial photography and a preliminary decision tree of the land cover classification. Four hundred and fifty preselected spectrally unique areas were determined and plotted on field maps for field verification and the coordinates of their center points were programmed for use with aircraft global positioning systems. In addition, 57 - 1:63,360 scale quadrangle color infrared plots of the Landsat TM data were produced for the placement of additional field sample sites and for navigational purposes with the helicopters. The classification

Landsat Thematic Mapper Scene
Path 81/Row 10 Shifted 42% South
July 6, 1992



Tidal Stage :
1.16 ft. Mean Low Water

Landsat Thematic Mapper Scene
Path 79/Row 10 Shifted 21% South
July 8, 1992



Tidal Stage :
3.36 ft. Mean Low Water

Band Combination : 4,3,2

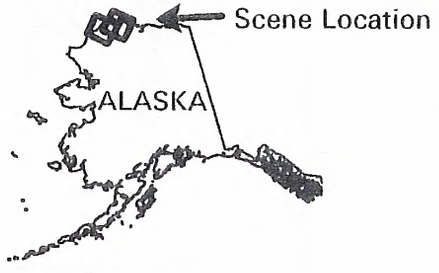


Figure 4. The two terrain corrected Landsat Thematic Mapper images.

scheme for the land cover inventory was developed through a series of meetings with biologist familiar with the vegetation and previous work, i.e. Markon and Derkson 1994. The classification scheme consisted of eight major categories and nineteen subcategories (Table 1).

Table 1. The classification scheme for the NPR-A

1.0 Water
- 1.1 Clear
- 1.2 Turbid
- 1.3 Ice

2.0 Aquatic
- 2.1 Carex aquatilis
- 2.2 Arctophylla fulva

3.0 Flooded Tundra
- 3.1 Low-centered Polygons
- 3.2 Non-patterned

4.0 Wet Tundra

5.0 Moist Tundra
- 5.1 Sedge/Grass Meadow
- 5.2 Tussock Tundra
- 5.3 Moss/Peat/Lichen

6.0 High Centered Polygons
- 6.1 Shrub
- 6.2 Graminoid
- 6.3 Moss/Lichen

7.0 Shrub
- 7.1 Dwarf
- 7.2 Low
- 7.3 Riparian

8.0 Barren Ground
- 8.1 Dunes/Dry Sand
- 8.2 Sparsely Vegetated
- 8.3 Other

Field verification

A custom field data collection card (Kempka *et al.* 1994) was developed and used to record field information (Fig. 5). Two four person helicopter crews were designated to perform the field assessment. Each crew consisted of a pilot, biologist, recorder, and navigator. The co-pilot seat was occupied by the person who runs the GPS equipment and interprets the field map. The biologist was the person most knowledgeable regarding wetland vegetation, and the recorder would verify vegetation composition and record land cover type percentages and other data on the field form. Low-level helicopter surveys are a very effective method of field data collection since a much broader area can be covered with an orthogonal view from above, similar to a satellite sensor, and for use in remote areas that are difficult to access. Initial sampling was performed with both crews on the ground to verify and standardize the classification and sampling techniques. After initial on-the-ground sampling, the majority of the sample sites were observed visually by helicopter to determine the percent cover for each species and an overall land cover class. Ground verification was performed when identification of dominant vegetation and/or species was uncertain. The data collected on 344 sample sites were used in the classification process as training sites (Table 2). The remaining 276 field sites were set aside for accuracy assessment

Rev 7/7/94

National Petroleum Reserve Alaska - Field Form

Site Number	Soil Type	Observer	Obs Date (Mo Day Year)	Obs Level	%Slope (Avg)	Aspect (Avg)	Elev'n
11		FARIDY	7 / 12 / 94	1 2 3 4			

Air Photo (Flight Line / Photo / Quad)	Photo Source	1:63K Quad
		Meade R C-3

LAT (GPS) uncorrected (Degrees Min Seconds)	LONG (GPS) uncorrected (Degrees Min Seconds)	GPS/Local Time (Hr Min Seconds)
70 : 44 . 67	157 : 45 . 79	

UTM Easting	uncorrected	UTM Northing	uncorrected

WATER	BARREN GROUND	FLOODED TUNDRA	WET TUNDRA	MOIST TUNDRA	SHRUB	SPARSELY VEGETATED	AQUATIC
Clear	Dunes/Dry Sand	Pond Perimeter		(Sedge/Grass Meadow)	Dwarf		Emergent
Turbid	Other	Low Centered Polygon		Tussock Tundra	Low		Submergent
Ice				Moss/Peat	Grain/Forb/Peat		
					Riparian Shrub		

NOAA Coastwatch Classification	1.6
Viereck Classification	3A2

% Coverage	SHRUBS		Height
2	(Willow)	Salix spp.	
	Tundra dwarf birch	Betula glandulosa	
	Greenland labrador tea	Ledum groenlandicum	
	Bog blueberry	Vaccinium uliginosum	
	Black crowberry	Empetrum nigrum	
	Cloudberry	Rubus chamaemorus	
	Mountain cranberry	Vaccinium vitis-idaea	
	Arctic bell-heather	Cassiope tetragona	

% Coverage	HERBACEOUS	
20	(Moss)	Bryoid spp.
	Buttercup	Ranunculus spp.
	Saxifage	Saxifraga spp.
	Arctic Sweet Coltsfoot	Petasites frigid
	Mountian Avens	Dryas spp.
	Marsh groundsel	Senecio congestus
	Low starwort	Stellaria spp.
	Marsh cinquefoil	Potentilla palustre
	Sudetan Lousewort	Pedicularis spp.
	River Beauty	Epilobium latifolium
	Arctic poppy	Papaver spp.
	Clustered Valerian	Valeriana capitata
	Common marsh marigold	Caltha palustns
	Mustard	Draba spp.
	Buckwheat	Poliginum spp.
	Artic Rumex	Rumex spp.
22	Subtotal % Cover	

% Coverage	GRASS/SEDGE/...	
15	(Water Sedge)	Carex Aquatilis
58	(Sedge Cother)	Carex spp.
	Pendant Grass	Arctophylla fulva
	Cotton-grass	Eriophorum spp.
	Broadleaf Arctic Bent-grass	Arctagrostis latifolia
	Creeping Alkali Grass	Puccinellia phryganodes
	Arctic bluegrass	Poa spp.
	Tussock Cotton-grass	Eriphorum spp.
	Tufted hairgrass	Deschampsia ceaspitosa
	Scurvy-grass	Cochlearia officinalis
	Wool bluegrass	Poa lanata
	Rush	Juncus spp.
	Woodrush	Luzula spp.
	Mares tail	Mip
	Water horsetail	Equisetum spp.

% Coverage	NON-VEGETATED	
5	(Clear water)	
	Gravel	
	Ice	
	Mud	
	Rock	
	Sand	
	Silt	
	Turbid Water	
	Plant Debris	
78	Subtotal % Cover	
100	GRAND TOTAL % COVER	

C#	COMMENTS
	R1, S25 nesting arctic loon

Figure 5. Field data collection card for the NPR-A.

Table 2. The number of field samples per class and number withheld for accuracy assessment.

Category	Field Samples	Accuracy Assessment
Clear Water	14	14
Turbid Water	6	3
Ice	5	5
Carex aquatilis	30	12
Arctophylla fulva	31	15
Low Centered Polygon	54	20
Non-pattern	52	24
Wet Tundra	76	29
Sedge/Grass Meadow	58	27
Tussock Tundra	46	22
Moss/Peat/Lichen	18	6
HCP Shrub	36	17
HCP Graminoid	59	27
Dwarf Shrub	18	7
Low Shrub	33	15
Riparian Shrub	22	10
Dunes/Dry Sand	21	10
Sparsely Vegetated	23	7
Barren Ground Other	18	6
TOTAL	**620**	**276**

Classification Scheme

The classification scheme for the field work consisted of eight major classes and eighteen minor classes. The classification scheme was revised for the Landsat TM classification due to sensor limitations differiencating between morphological differences between classes (Table 3). The greatest change between the two classification schemes was the omission of the high centered polygon class from the TM classification scheme. This omission was due to the fact that the high centered polygon class was indeed different morphologically from the other classes but was not spectrally unique and identifiable because of the similar vegetation types. Therefore, the high centered polygon classes were lumped into their perspective vegetation classes The only other change that was made was merging the riparian shrub class with the low shrub class. These classes were merged because the height difference between the two classes was not separable with the TM data (low shrub 30-100 cm, riparian shrub >100 cm). The differentiation of shrub was not possible due to the fact that the actual biomass is not significantly different. It is possible to

create a riparian shrub class using the hydrography and GIS overlay techniques. This procedure was not applied for fear of losing detail in the final classification. The definitions for the classification scheme and a decision tree were developed in order to eliminate any confusion in the classification scheme (see Appendix A).

Table 3. Comparison between the initial and Landsat TM classification schemes.

Initial Classification Scheme	**Landsat TM Classification Scheme**
1.0 Water	1.0 Water
1.1 Clear	1.1 Clear
1.2 Turbid	1.2 Turbid
1.3 Ice	1.3 Ice
2.0 Aquatic	2.0 Aquatic
2.1 Carex aquatilis	2.1 Carex aquatilis
2.2 Arctophylla fulva	2.2 Arctophylla fulva
3.0 Flooded Tundra	3.0 Flooded Tundra
3.1 Low-centered Polygons	3.1 Low-centered Polygons
3.2 Non-patterned	3.2 Non-patterned
4.0 Wet Tundra	4.0 Wet Tundra
5.0 Moist Tundra	5.0 Moist Tundra
5.1 Sedge/Grass Meadow	5.1 Sedge/Grass Meadow
5.2 Tussock Tundra	5.2 Tussock Tundra
5.3 Moss/Peat/Lichen	5.3 Moss/Peat/Lichen
6.0 High Centered Polygons	
6.1 Shrub	
6.2 Graminoid	
6.3 Moss/Lichen	
7.0 Shrub	6.0 Shrub
7.1 Dwarf	6.1 Dwarf
7.2 Low	6.2 Low
7.3 Riparian	
8.0 Barren Ground	7.0 Barren Ground
8.1 Dunes/Dry Sand	7.1 Dunes/Dry Sand
8.2 Sparsely Vegetated	7.2 Sparsely Vegetated
8.3 Other	7.3 Other

Classification

The first process was to subset the two images to the project area. The subset was accomplished using digital USGS 1:63,360 scale quadrangle boundaries and the 70° latitude demarcation. The images were then classified separately to eliminate the radiometric differences due to the different acquisition dates in the images. The classification process described below was performed first on path 79/row 10 and then path 81/row 10 was classified using the same techniques (Fig. 6). However, path 81/row 10 had a few areas where low level clouds created misclassifications. The final classification for the cloudy areas were edited in Imagine's Raster Editor using aerial photography.

The second step was to generate new band combinations in order to enhance the Landsat TM data. Four ratios were generated using the raw bands (4/3, 5/4, 7/5). The ratios were created to enhance the separation between classes by dividing the reflectance of one band by the reflectance of another band. In addition the first principal component was generated on the first 3 bands of the raw TM imagery to reduce the redundancy of data in the visible bands. The four new bands were subset into a single 10 band file containing the 6 raw TM bands, 3 ratios, and first principal component. The new 10 band file was used for the remaining analysis.

The supervised training areas were seeded in ERDAS Imagine using spectral bounds as the limit for seed growth. Standard deviations of the seeded areas were kept to about 3 and all seeded areas were required to be over 15 pixels (approximately 3.75 acres) in size. Following the supervised seeding process a spectral pattern analysis and DIVERGE analysis were run on the supervised seeds in order to determine optimal band selection. Spectral pattern analysis is a graphical method of comparing the mean digital number of the different classes across the different bands. DIVERGE is a statistical program in ERDAS that calculates the spectral distance between class signatures to determine the bands that have the maximum seperability between classes. The procedure to select the optimal bands was performed to determine which bands would give the best separation between the classes and which bands had redundant and/or confusing information. The bands with redundant and/or confusing information were removed during the classification process to reduce the processing time and enhance the classification. The best band combination from these analysis was band 3, 4, 5, ratio 4/3, and the first principal component of the visible bands.

After the selection of the optimal band combination, a combined classification approach called cluster magic (Chuvieco and Congalton 1988) was used for the classification. The cluster magic approach uses a statistical program to cluster the spectrally unique clusters from the unsupervised signatures with the signatures of the supervised training areas. In this approach, the spectrally unique areas are labeled according to the supervised training areas. Therefore, 250 unsupervised clusters were generated using ISODATA and clustered with the supervised signatures. The clustering process was repeated until all of the spectral classes were adequately matched and labeled. This process resulted in a single band image with 16 labeled categories.

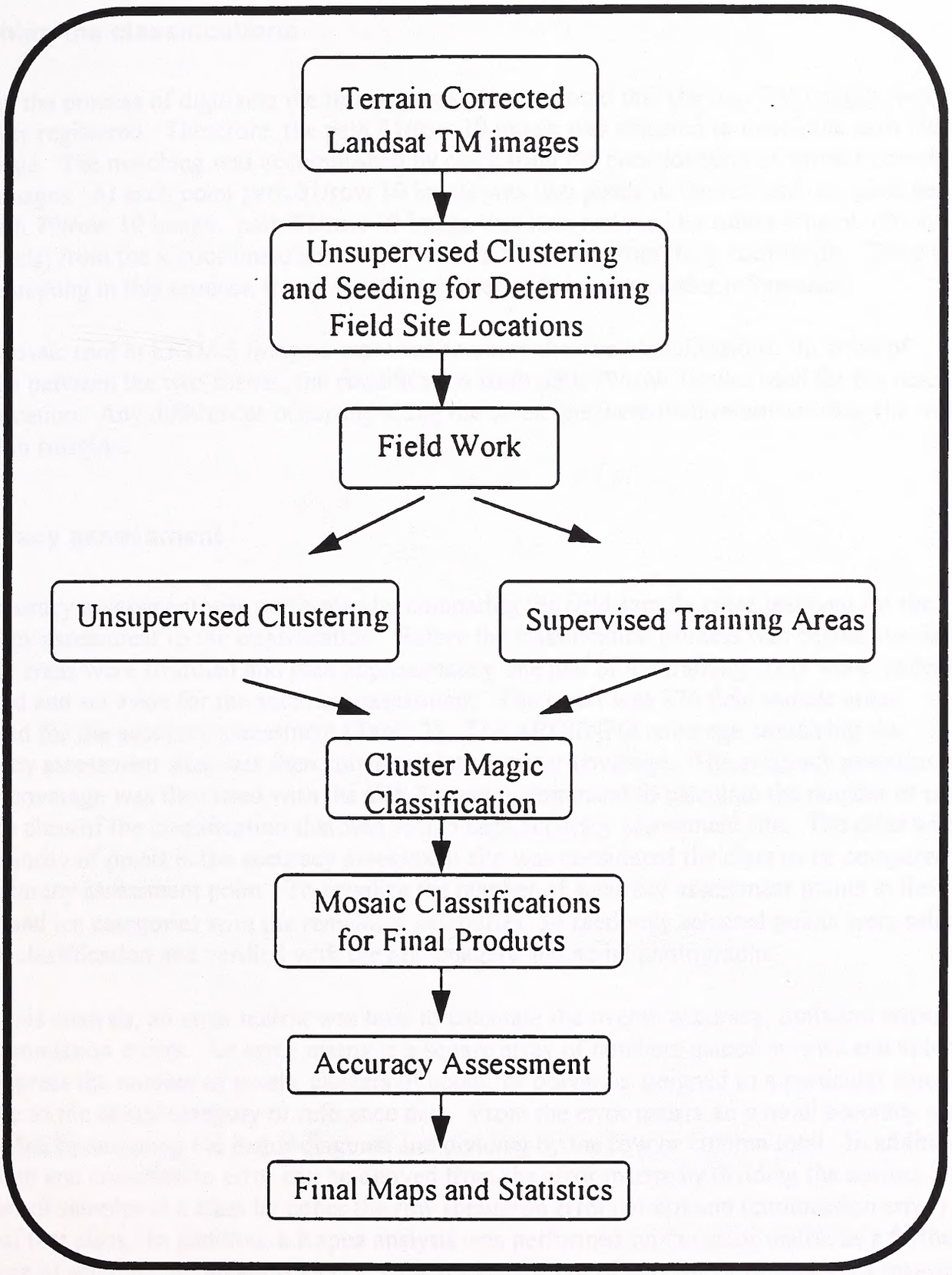


Figure 6. The classification process of the NPR-A.

Stitching the classifications

During the process of digitizing the training areas, it was noted that the two TM images were not properly registered. Therefore, the path 81/row 10 image was adjusted to match the path 79/row 10 image. The matching was accomplished by comparing the pixel location of various points on both images. At each point path 81/row 10 image was two pixels to the left and one pixel below the path 79/row 10 image. path 81/row 10 image was then matched by subtracting 60 (30 meters * 2 pixels) from the x coordinate and 30 (30 meters * 1 pixel) from the y coordinate. There was no resampling in this process, it was strictly a matter of fixing the header information.

The Mosaic tool in ERDAS Imagine was used to stitch the two classifications. In areas of overlap between the two scenes, the classification from path 79/row 10 was used for the resulting classification. Any differences occurring along the stitch line were then removed using the raster editor in Imagine.

Accuracy assessment

An accuracy assessment was performed by comparing the field sample areas reserved for the accuracy assessment to the classification. Before the classification process was begun, the field sample areas were stratified and then approximately one half of the training areas were randomly selected and set aside for the accuracy assessment. The result was 276 field sample areas reserved for the accuracy assessment (Table 2). The ARC/INFO coverage containing the accuracy assessment sites was then converted into a raster coverage. The accuracy assessment raster coverage was then used with the GIS Summary command to calculate the number of pixels in each class of the classification that was within each accuracy assessment site. The class with the majority of pixels in the accuracy assessment site was considered the class to be compared to the accuracy assessment point. To equalize the number of accuracy assessment points in the water and ice categories with the remaining categories, 54 randomly selected points were selected on the classification and verified with the raw imagery and aerial photographs.

From this analysis, an error matrix was built to calculate the overall accuracy, omission errors, and commission errors. An error matrix is a square array of numbers placed in rows and columns that express the number of pixels, clusters of pixels, or polygons assigned to a particular category relative to the actual category or reference data. From the error matrix an overall accuracy can be computed by summing the major diagonal and dividing by the row or column total. In addition. omission and commission error can be derived from the error matrix by dividing the correct number of samples in a class by either the row (omission error) or column (commission error) total of that class. In addition, a Kappa analysis was performed on the error matrix as a further measure of accuracy (Congalton 1991). Cohen's coefficient of agreement (Kappa) is a measure of overall agreement in the error matrix after chance agreement is removed from consideration. In other words, Kappa attempts to provide a better measure of agreement by adjusting the overall accuracy for chance agreement or that agreement that might be contributed solely by chance matching of the two maps. In addition to calculating Kappa, confidence intervals can be calculated using the approximate large sample variance. The large sample variance can then be used to test

if the agreement between the classification and reference data is significantly different from zero or a random classification with the Z statistic.

Eider habitat

In the spring of 1994, the U.S. Fish and Wildlife Service conducted an eider survey using fixed-wing aircraft and a GPS unit to determine the location of eider sightings. The point locations were used to generate a point coverage in ARC/INFO and produce a 1:100,000 plot of the locations to be used in conjunction with the TM color plots for the field work. After the classification was performed the eider point coverage was overlain on the Landsat TM image to determine which water bodies the eiders used. The boundary of each water body was then digitized into an ARC/INFO polygon coverage. The water body coverage was then used to extract land cover statistics from the Landsat TM classification for the known eider sightings. The statistics were then summarized into general habitat characteristics for the spectacled eider.

Results

Classification

The final results of the Landsat TM classification are: 39% moist tundra, 21% clear water, turbid water or ice, 15% flooded tundra, 11% shrub, 8% wet tundra, 4% aquatic vegetation, and 2% barren ground (Fig. 7). The area and percentage for each of the seven major classes (Table 4) as well as the sixteen minor classes (Table 5) were calculated. Hard copy maps were also created for the entire study area (Fig. 8).

Table 4. The area and percentage of the seven major classes.

CLASS NAME	HECTARES	ACRES	PERCENTAGE
Water	6,013,893	1,486,033	20.8%
Aquatic	1,120,894	276,973	3.9%
Flooded Tundra	4,397,427	1,086,604	15.2%
Wet Tundra	2,319,527	573,155	8.0%
Moist Tundra	11,469,135	2,834,023	39.6%
Shrub	3,167,026	782,572	10.9%
Barren Ground	467,634	115,552	1.6%
TOTAL	**28,955,535**	**7,154,913**	**100.0%**

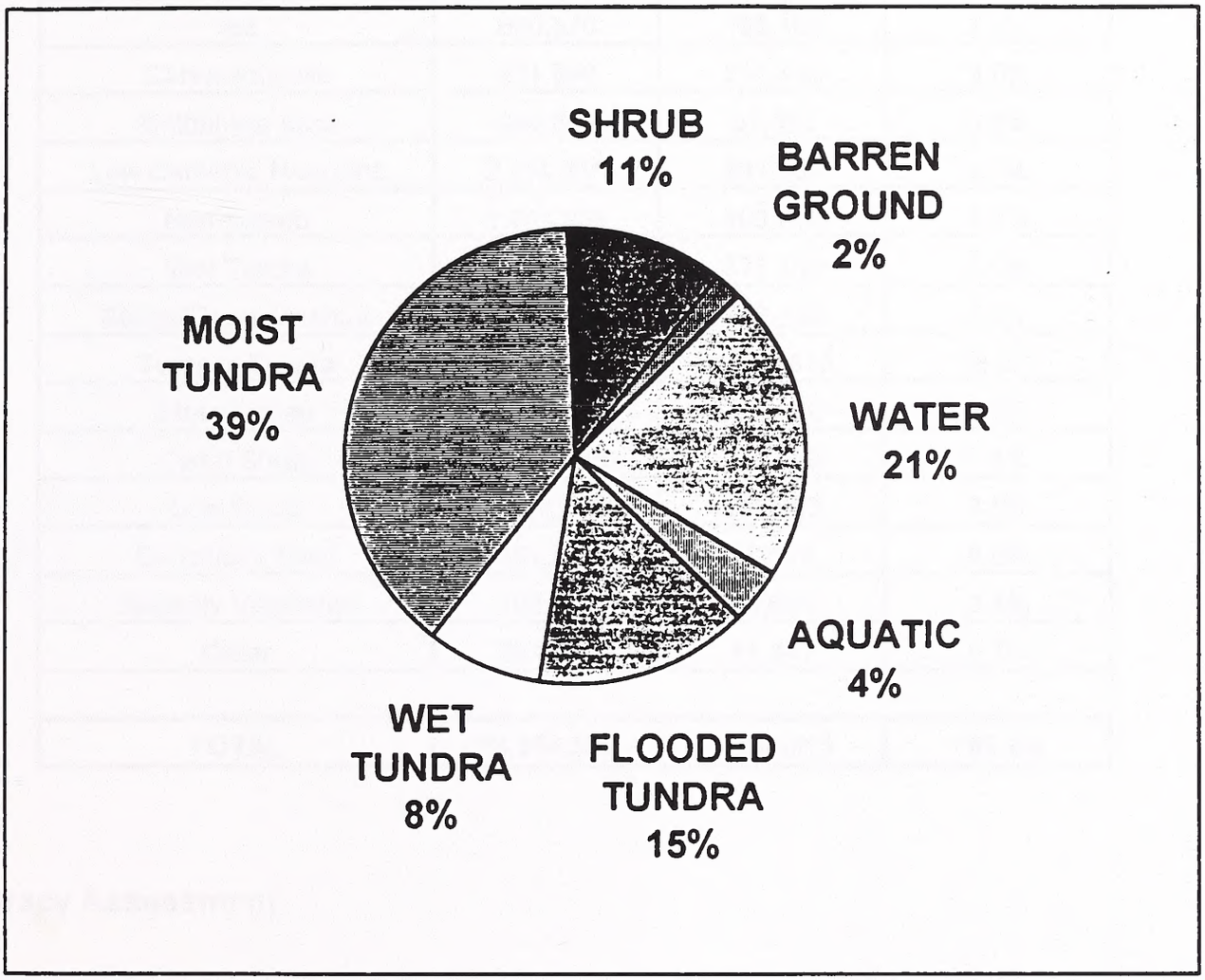


Figure 7. Results of the Landsat TM classification.

Eider Analysis

The results of the spectacled eider analysis indicate that for the nine water bodies sampled the averaged percentage of cover types included 73% water, 12% Carex aquatilis, 5% Arctophylla fulva, 3% wet tundra, 2% low centered polygons, and 2% non-pattern. The size of the lakes ranged from 3 hectares to 965 hectares with an average size of 282 hectares.

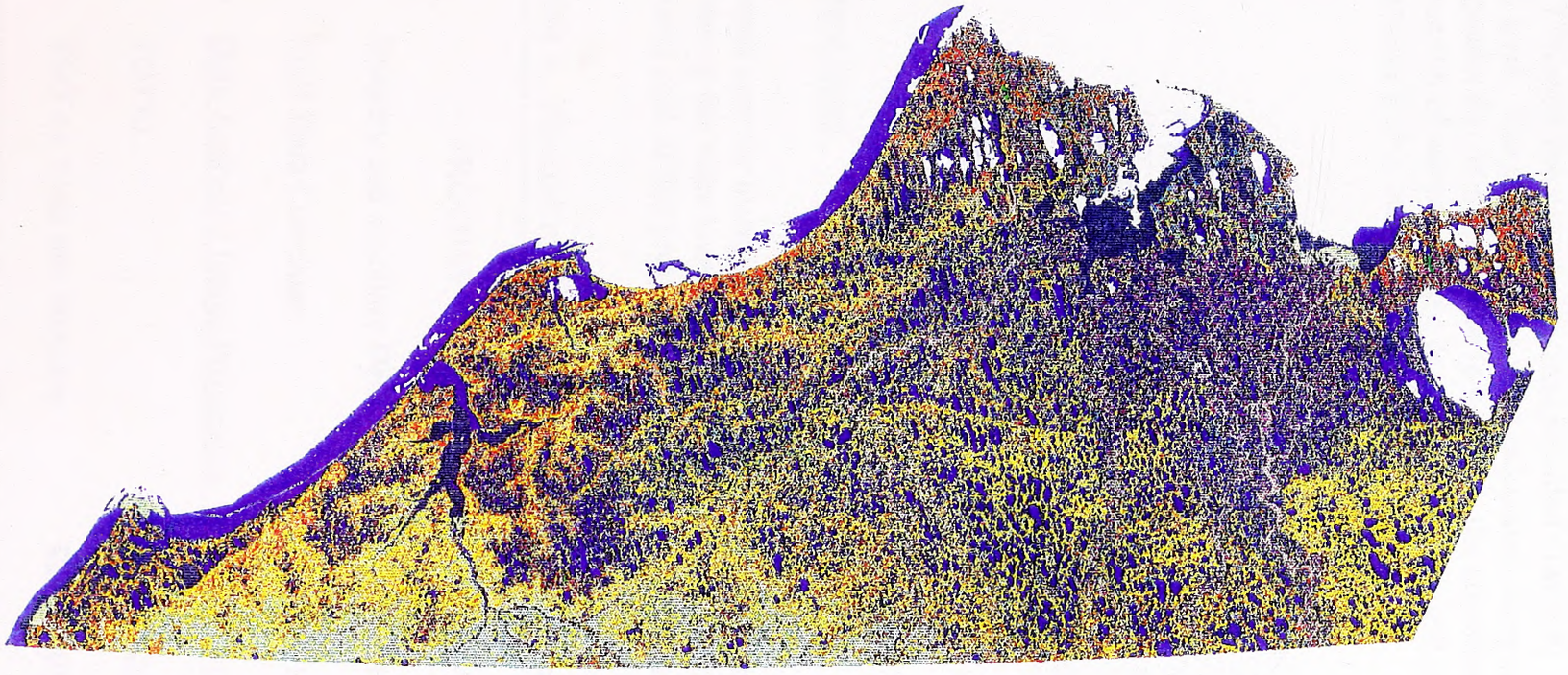
Table 5. The area and percentage of the sixteen minor classes.

CLASS NAME	HECTARES	ACRES	PERCENTAGE
Clear Water	3,078,616	760,726	10.6%
Turbid Water	2,254,707	557,138	7.8%
Ice	680,570	168,169	2.4%
Carex aquatilis	871,996	215,470	3.0%
Arctophylla fulva	248,899	61,503	0.9%
Low Centered Polygons	2,756,358	681,096	9.5%
Non-pattern	1,641,069	405,508	5.7%
Wet Tundra	2,319,527	573,155	8.0%
Sedge/Grass Meadow	2,534,744	626,335	8.8%
Tussock Tundra	8,108,535	2,003,619	28.0%
Moss/Lichen	825,856	204,069	2.9%
Dwarf Shrub	2,140,656	528,956	7.4%
Low Shrub	1,026,370	253,616	3.5%
Dunes/Dry Sand	151,817	37,514	0.5%
Sparsely Vegetated	108,019	26,691	0.4%
Other	207,797	51,347	0.7%
TOTAL	**28,955,535**	**7,154,913**	**100.0%**

Accuracy Assessment

The accuracy assessment included all major classes and all of the minor classes with the exception of turbid water and moist tundra - moss/lichen. The turbid water was not included because of inadequate samples for both the classification and accuracy assessment and due to the differences in image acquisition date, time of field sampling, and air photo acquisition date. The moist tundra - moss/lichen class was not included because of inadequate field samples for performing both the classification and accuracy assessment. The high centered polygon class sampled in the field was included in the accuracy assessment of the major classes but was not included in the minor classes due to inadequate correspondence between the minor classes and the high centered polygon class. For example, the high centered polygon shrub class will nicely group with the major class shrub, but determining if the high centered polygon shrub class was dwarf shrub or low shrub was not as feasible.

NPR-A Phase 1 Final Classification



Legend

Class_name	Class_name
CLEAR WATER	MOIST TUNDRA - TT
TURBID AND SHALLOW WATER	MOIST TUNDRA - M/L
ICE	SHRUB - DWARF
AQUATIC - CAREX	SHRUB - LOW
AQUATIC - ARCTOPHILA	SHRUB - RIPARIAN
FLOODED TUNDRA - LCP	BARREN GROUND - DUNES/DRY SAND
FLOODED TUNDRA - NONPATTERN	BARREN GROUND - SPARSE VEG.
WET TUNDRA	BARREN GROUND - MUD
MOIST TUNDRA - SGM	

Figure 8. The final classification of the NPR-A phase A.

Due to variations in the wet tundra class while field sampling, the accuracy assessment was run twice, once with the wet tundra class and once omitting the wet tundra class. The overall accuracy of the major categories without the wet tundra class was 91% and with the wet tundra class was 84%. The overall accuracy of the minor classes was 82% with out the wet tundra class and 77% with the wet tundra class included (Table 6). All four matrices were significant at the 99% level. The error matrices were calculated along with the omission and commission errors (Appendix B). It is important to note that the classification is based on water percentage and the fluctuation of water from the date of imagery to field collection may be the cause of the lower accuracies with a more detailed classification.

Table 6. The accuracy assessment of the phase A classification.

	Overall Accuracy	KHAT Accuracy	Z statistic
Major categories w/o Wet Tundra	91%	89%	42.18*
Major categories with Wet Tundra	84%	81%	33.16*
Minor categories w/o Wet Tundra	82%	80%	26.47*
Minor categories with Wet Tundra	77%	74%	29.07*

* Significant at the 99% level

Project Cost

The total cost for identifying the land cover in the western NPR-A with Landsat TM data and correlating the eider locations to the land cover classification was carefully documented (Table 8). The total cost of this project was $0.07 per hectare (less than $0.03 per acre).

Table 8. The cost of identifying the land cover in the western NPR-A with Landsat TM data.

PROCESS	COST
Imagery and Ancillary Data	$12,852
Field Data Collection	$104,000
Data Analysis / Image Processing	$109,148
TOTAL	**$226,000**
TOTAL Cost per Hectare	**$226,000/3,200,000 = $0.07**

Final Products

The primary product of this project is a digital database of the 16 land cover classes for the western NPR-A. Hard copy maps with acreage statistics were also created of the entire project area at a scale of 1:250,000. Selected 1:63,360 scale maps were also produced. In addition, for viewing purposes and future analysis, the 620 field samples were digitized from the field maps into ARC/INFO and the field site database was related to the ARC/INFO coverage. The result was an ARC/INFO coverage of the field sites with the attribute data. A final report describing the analysis and technical design was also delivered to the client.

Conclusions

The National Petroleum Reserve in Alaska is expected to have increased use in the next decade. Management issues require current information on land cover inventory and critical habitat data over the 9.4 million hectares of the NPR-A. The three phases of the project are planned for completion in 1995, 1996, and 1997, respectively. This joint project by the BLM-Alaska, Ducks Unlimited, U.S. Fish and Wildlife Service, North Slope Borough and Pacific Meridian Resources has so far provided a low cost and efficient means to gain valuable information on the land cover types in the western portion of the NPR-A.

Phase A, the western portion, has used two near date Landsat Thematic Mapper satellite scenes. These scenes were used to classify the project area into land cover categories. Use of rotary aircraft (helicopters) and global positioning system (GPS) technology were used to acquire field data over 620 sites, 344 of which were used in the computer aided classification process as training sites and 276 were used for accuracy assessment. The classification scheme consisted of seven major categories and sixteen subcategories. A combined classification approach on the satellite data called cluster magic was used. Results of this classification suggest dominant habitats to be 39% moist tundra, 21% open water, 15% flooded tundra, 11% shrub, 8% wet tundra, 4% aquatic, and 2% barren ground. The overall accuracy of the major categories was 91%, with an 82% overall accuracy for the minor categories. Analysis of known spectacled eider locations resulted in categorizing the land cover types where spectacled eiders were sighted in the field. The result of this analysis suggest the land cover mix related to eider sightings is as follows: 73% water, 12% Carex aquatilis, 5% Arctophylla fulva, 3% wet tundra, 2% low centered polygons, and 2% non-pattern. The cost to complete this project was $0.08 per hectare ($0.03 per acre).

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APPENDIX A

The definitions for the classification scheme and decision tree

DEFINITIONS FOR THE NPR-A PHASE A

1.0 WATER (≥ 80% water)
- 1.1 Clear Water - (depth > 1 meter and no turbidity)
- 1.2 Turbid Water - (depth ≤1 meter and/or turbid)
- 1.3 Ice - (ice ≥ 60%)

2.0 AQUATIC (≥50% water and <80% water and > 10cm in depth)
- 2.1 Carex aquatilis - (> 15% Carex aquatilis)
- 2.2 Arctophylla fulva - (>15% Arctophylla fulva)

3.0 FLOODED TUNDRA (≥25% water and <50% water and < 10cm in depth)
- 3.1 Low Centered Polygons (≥ 5% Sedge/Grass)
- 3.2 Non -pattern (< 5% sedge/Grass)

4.0 WET TUNDRA (≥ 10% and < 25% water)

5.0 MOIST TUNDRA (<10% water, < 40% shrub, composed mostly of sedges, grasses, rushes and moss/peat/lichen complex)
- 4.1 Sedge/Grass Meadow - (≥ then 50% sedge/grass and <40% tussock)
- 4.2 Tussock Tundra - (≥ 40% tussock cotten grass)
- 4.3 Moss/lichen - (≥ 50% moss and/or lichen)

6.0 SHRUB (< 5% water and ≥40% shrub)
- 5.1 Dwarf - (≤ 30cm in height)
- 5.2 Low - (> 30cm in height)

7.0 BARREN GROUND (0-30% vegetated)
- 6.1 Dunes/dry sand - (≤10% vegetation and < 10% wet sand)
- 6.2 Sparsely Vegetated - (10-30% vegetated)
- 6.3 Other - (< 10% vegetation and ≥ 10% wet sand)

DECISION TREE FOR THE NPR-A PHASE A

A) Ice.....Ice
Water.....B

B) ≥ 80% water C
< 80% water.....D

C) depth ≥ 1 meter and no turbidity.....Clear Water
depth < 1 meter and /or turbid.....Turbid Water

D) ≥ 50% water and < 80% water.....E
< 50% water.....F

E) ≥ 15% Arctophylla.....Arctophylla fulva
< 15% Arctophylla.....Carex aquatilis

F) ≥ 26% water and < 50% water.....G
< 26% water.....H

G) ≥ 5% sedge/grass.....Flooded Tundra LCP
< 5% sedge/grass.....Flooded Tundra NP

H) ≥ 5% water and < 26% water.....Wet Tundra
< 5% water.....I

I) ≥ 30% vegetated.....J
< 30% vegetated.....N

J) ≤ 40% shrub.....K
> 40% shrub.....M

K) < 50% moss/lichen and < 40% tussock.....Sedge/Grass Meadow
≥ 50% moss/lichen and ≥ 40% tussock.....L

L) < 50% moss/lichen and ≥ 40% tussock .....Tussock Tundra
≥ 50% moss/lichen.....Moss/lichen

M) Shrubs ≤ 30cm in height.....Dwarf Shrub
Shrubs > 30cm in height.....Low Shrub

N) ≥ 10% vegetated.....Sparsely Vegetated
< 10% vegetated.....O

O) < 10% wet sand.....Dunes/Dry Sand
≥ 10% wet sand.....Mud

APPENDIX B

Error matrices for the NPR-A phase A classification

MAJOR CATEGORIES NOT INCLUDING WET TUNDRA *

(HCP ** shrub included in shrub category and HCP graminoid included in moist tundra)

CLASSIFICATION

		Water	Aquatic	Flooded Tundra	Moist Tundra	Shrub	Barren Ground	Total	USERS
	Water	66	1					67	98%
	Aquatic		22	3	1	1		27	81%
	Flooded Tundra		2	40	1			43	93%
REFERENCE	Moist Tundra			3	69	7		79	87%
	Shrub			1	6	40		47	85%
	Barren Ground						24	24	100%
	Total	66	25	47	77	48	24	287	
	PRODUCERS	100%	88%	85%	90%	83%	100%		

OVERALL ACCURACY =

261/287 =

91%

* During field sampling the Wet Tundra class was not well defined and as a result the Wet Tundra class overlapped into similar classes.

** HCP (High Centered Polygons) class was sampled in the field but the differencein this class was morphological and not necessaily a vegetative difference. Therefore, the HCP classes were grouped into similar classes at this level. At the more detailed level the HCP classes were not included in the accuracy assessment, but may be at later flme when each HCP site can be reclassed.

MAJOR CATEGORIES INCLUDING WET TUNDRA
(HCP shrub included in shrub category and HCP graminoid included in moist tundra)

CLASSIFICATION

		Water	Aquatic	Flooded Tundra	Wet Tundra	Moist Tundra	Shrub	Barren Ground	Total	USERS
	Water	66	1						67	98%
	Aquatic		22	3	3	1	1		30	73%
	Flooded Tundra		2	40	1	1			44	91%
	Wet Tundra		1	8	14	9	1	1	34	41%
REFERENCE	Moist Tundra			3	2	69	7		81	85%
	Shrub			1		6	40		47	85%
	Barren Ground				1			24	25	96%
	Total	66	26	55	21	86	49	25	328	
	PRODUCERS	100%	85%	72%	67%	80%	82%	96%		

OVERALL ACCURACY =
275/328 =
84%

MINOR CATEGORIES (including Wet Tundra)
HCP classes not included

classification

		Water		Aquatic		Flooded Tundra		Wet T.	Moist Tundra		Shrub		Barren			
		cw	ice	ca	af	lcp	np	wt	sgm	tt	ds	ls	dds	sv	Total	USERS
	cw	50	1		1										52	96%
	ice	1	19												20	95%
r	ca			7		1	2	2							12	58%
e	af			6	9			1							16	56%
f	lcp					15	4			1					20	75%
e	np			2		4	17	1							24	71%
r	wt			1		8		14	4	2					29	48%
e	sgm					1		2	22	2					27	81%
n	tt					1			1	20					22	91%
c	ds										4	3			7	57%
e	ls					1				3	4	16			24	67%
	dds												9	2	11	82%
	sv													5	5	100%
	Total	51	20	16	10	31	23	20	27	28	8	19	9	7	269	
PRODUCER		98%	95%	43%	90%	48%	74%	70%	81%	71%	50%	84%	100%	71%		

OVERALL ACCURACY =
207/269 =
77%

cw = water, ice = ice, ca= Carex aquatilis, af = arctophylla fulva, lcp= low centered polygons, np = nonpattern, wt = wet tundra, sgm= sedge/grass meadow, tt= tussock tundra, ds= dwarf shrub, ls = low shrub, dds= dunes/dry sand, sv= sparsely vegetated

MINOR CATEGORIES
HCP classes not included

classification

		Water		Aquatic		Flooded Tundra		Moist Tundra		Shrub		Barren			
		cw	ice	ca	af	lcp	np	sgm	tt	ds	ls	dds	sv	Total	USERS
	cw	50	1		1									52	96%
	ice	1	19											20	95%
r	ca			7		1	2							10	70%
e	af			6	9									15	60%
f	lcp					15	4		1					20	75%
e	np			2		4	17							23	74%
r	sgm					1		22	2					25	88%
e	tt					1		1	20					22	91%
n	ds									4	3			7	57%
c	ls					1			3	4	16			24	67%
e	dds											9	2	11	82%
	sv												5	5	100%
	Total	51	20	15	10	23	23	23	26	8	19	9	7	234	
PRODUCER		98%	95%	47%	90%	65%	74%	96%	77%	50%	84%	100%	71%		

OVERALL ACCURACY =
193/234 =
82%

cw = water, ice = ice, ca= Carex aquatilis, af = arctophylla fulva, lcp= low centered polygons, np = nonpattern, wt = wet tundra, sgm= sedge/grass meadow, tt= tussock tundra, ds= dwarf shrub, ls = low shrub, dds= dunes/dry sand, sv= sparsely vegetated